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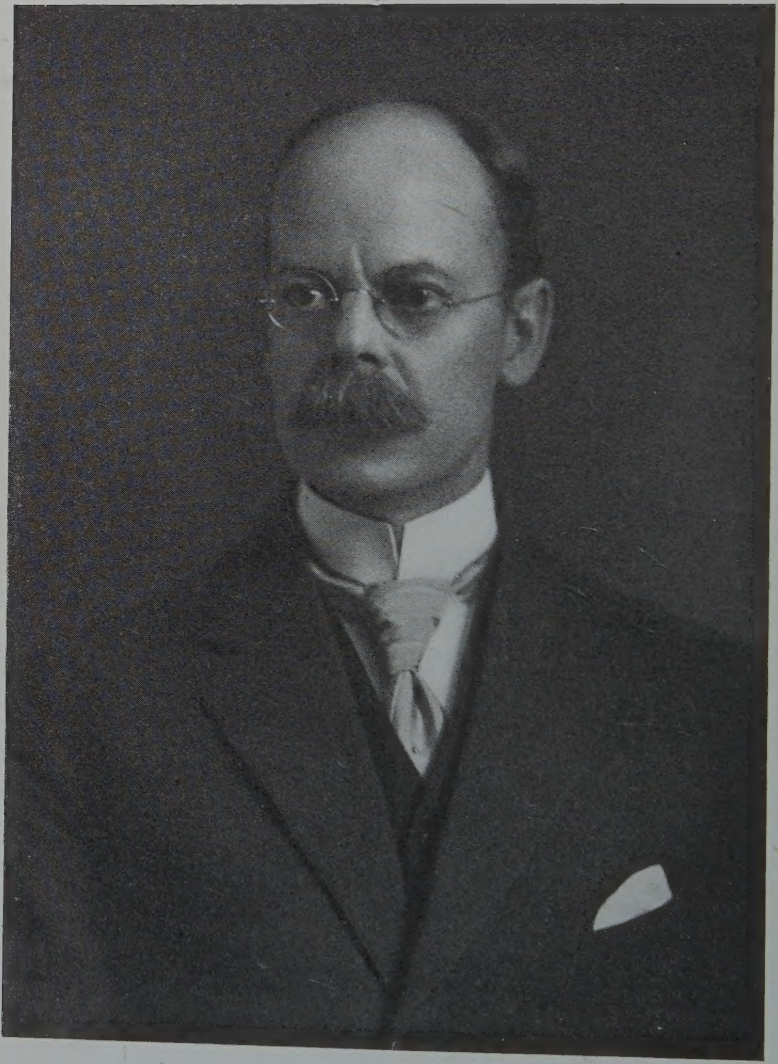

Leonard Metcalf
President, Boston Society of Civil Engineers
1919–1920

Vol. VII JANUARY, 1920 No. 1

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

PAPERS IN THIS NUMBER.

Discussion of the "Cost-Plus and Other Forms of Contracts."

Memoirs of deceased members.

MINUTES OF MEETING.

BOSTON, December 17, 1919. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 7.50 o'clock by the President, Leonard Metcalf.

There were 96 members and visitors present.

The record of the last meeting was read and approved.

The President reported for the Board of Government the election of the following candidates to membership in the grades named:

Member: Carl S. Drake, Frederick A. Lovejoy, John E. L. Monaghan, Howard C. Thomas, Arthur C. Tozzer and Warren D. Trask.

Junior: A. Winton Caird.

The Secretary submitted, for the committees appointed for the purpose, the following memoirs of members of the Society: that of Leslie Peter Reed, prepared by Frank S. Bailey; and that of Charles E. Putnam, prepared by Edward W. Howe. The memoirs were accepted and ordered printed in the JOURNAL of the Society.

The President announced the death of Frederic P. Stearns, a past-president of the Society, which occurred December 1, 1919. The committee selected to prepare a memoir of Mr. Stearns consists of Allen Hazen and X. Henry Goodnough.

The speaker of the evening was Mr. Allen Hazen, who spoke most interestingly on the subject of "Hydraulic Fill Dams." The address was illustrated with lantern slides.

Adjourned.

S. E. Tinkham, *Secretary.*

APPLICATION FOR MEMBERSHIP.

[January 15, 1920.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

Price, Herman Scott, Boston, Mass. (Age 26, b. New York, N. Y.) Attended Cooper Institute of Technology, New York City, received a B.E. degree in civil engineering; 1915 to 1917, employed in constructing sub-stations and high potential transmission lines, with Westchester Lighting Company; 1917–1918, engaged in making scientific investigations of aëronautical instruments for War Department; 1918–1919, with United States Coast and Geodetic Survey. Refers to N. C. Grover, C. H. Pierce, H. B. Wood, M. R. Stackpole.

1127M

LIST OF MEMBERS.

ADDITIONS.

Abbott, Robinson........................35 Lincoln St., Malden, Mass.
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Hobson, George F..........1818 Ingleside Ter., N. W., Washington, D. C.
Horton, Freeman H...Care Florida State Highway Dept., Tallahassee, Fla.
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Thorpe, George H......................60 Prospect St., Hartford, Conn.
Wade, W. Newell.....................26 Albion Road, Wollaston, Mass.

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society rooms two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

MEN AVAILABLE.

497. Age 38. Graduate Boston Mechanic Arts High School in 1900. Experience, four years as landscape engineer; three years railroad work; two years as town engineer on municipal engineering; five years engineer of power station and factory maintenance; three years elevated and subway construction, and past two years in U. S. Navy, inspector mechanical equipment, navigating and commanding officer. Desires to return to professional work in the line of consulting civil or mechanical engineering. Salary desired, $3 000 per year.

498. Age 25. Graduate of Worcester Polytechnic Institute. Experience, drafting one year, and two years engineer on dry dock construction. Desires field engineering work. Salary desired, $200 per month.

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

DISCUSSION OF "COST-PLUS AND OTHER FORMS OF CONTRACTS."

By C. Frank Allen, Frank W. Hodgdon, Charles R. Gow, Charles M. Spofford, R. A. Hale, E. F. Larned, Leonard Metcalf, Victor H. Clarke, H. E. Wheeler, P. A. Shaw and James W. Rollins.

(Presented November 12, 1919.)

C. Frank Allen.* — What the speaker wishes to say upon this subject is in part stated by him in a publication printed after hearing the paper under discussion, and largely influenced by it. It is as follows:

"This emergency contract was drawn with rare skill and foresight and has proved most successful for the purposes intended. Its primary and direct object was to promote speed. The saving in time, peculiarly in cantonment construction, meant the earlier placing of our soldiers in the trenches, with the saving of lives from shortening the war.

"Forms of contract much used in construction may be classified as: lump sum, unit price, cost plus a fixed sum and cost plus percentage.

"The emergency contract is a modified cost plus percentage system, with a fixed sum as a limit or upset fee as a perfecting feature. The sliding scale adopted tends to act as a deterrent to unnecessarily increasing the costs, while the upset fee makes unprofitable a cost beyond a certain sum. In one structure costing $25 000 000, the upset fee was reached at $10 000 000, and no advantage to the contractor accrued beyond that sum.

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* 88 Montview Street, West Roxbury, Mass.; formerly professor of Railroad Engineering, Massachusetts Institute of Technology.

An adequate system of auditing, however, is essential to this form of government contract. Its success has aroused much favorable interest among engineers and contractors.

"It is accepted by engineers that, in the long run, with competitive contracts, the contractor's bid is made high enough to cover all risks in sight, many of which fail to materialize, but for which the owner pays. The owner effects a saving when he is able to assume the risk. If occasionally a contractor's bid is below cost, the contract is more difficult to enforce, and the quality of the work usually suffers in some degree. A cost-plus system removes the risk to the contractor. The owner, however, assumes new risks, — the efficiency of the contractor and an uncertainty as to the final cost.

"Where the conditions are not uncertain, so that the risk is small, and where complete plans are ready at the time the bids are made, and where also costs of materials and of labor are stable, lump-sum contracts will be favored by many engineers and their clients as simple, effective and cheaper. Where the conditions are understood, but the total quantities are not fully determined, the unit-price contract is indicated rather than the lump sum. The lines of demarcation between these two have been reasonably established already and do not need attention here.

"The conditions which dictated a cost-plus system for cantonment and other construction were the need for the utmost speed of execution, including the necessity for starting work before plans could be completed or perhaps even begun; the flexibility which allowed plans to be changed suddenly to meet physical conditions or newly adopted standards; the chance to utilize materials which from time to time proved most available; and the impossibility of knowing in advance the costs of materials and labor under new conditions suddenly created.

"To these were added the possibility of assigning the work promptly to the contractor best qualified to do it, taking into account energy, business responsibility and knowledge of local conditions.

"Furthermore, the private field for contractors' activities was suddenly restricted, and from patriotic instincts contractors stood ready to undertake almost any work, of whatever magnitude, provided only that they were assured against loss. Contracts have thus been completed at a percentage of profit which would not be acceptable in normal, active times.

"In March, 1919, while business is halting previous to the formal signing of the treaty of peace, the costs of labor and materials are so unstable that the value of the cost-plus contracts is abnormally great, for it must be expected that lump-sum bids will be high to cover possible changes in costs, especially with long time contracts.

"There are some disadvantages in the cost-plus system. Important among these is the fact that workmen will be more insistent upon high wages than on lump-sum work. Who is there to deny it to them? Experience also indicates that they are less alert and interested. Even the contractors are likely to suffer in efficiency if the prod of self-interest is lacking. If a contractor has several contracts, some lump-sum, others cost-plus, which will secure his most active interest and attention? It can hardly be doubted that a lump-sum system tends to secure a larger measure of efficiency of labor than does a cost-plus system.

"A serious criticism of the cost-plus system in emergency contracts has been that each contractor, in his zeal to speed up his work, competed disastrously with other contractors. The instability of prices, foreordained no doubt, was accentuated through the cost-plus contract.

"Municipal, state and government work demand competitive bidding. This is to diminish or prevent abuses growing out of political favoritism. Non-competitive cost-plus contracts are thus legally inadmissible. Furthermore, any system of cost keeping and auditing tends to be expensive, and unusual opportunities are opened for corrupting members of the cost-keeping force, who in some cases might even be appointed with sinister intent.

"It is possible, probably, to introduce into the cost-plus system competitive features sufficient to comply with the legal requirements of statutes or ordinances. Let the chief engineer prepare a careful estimate of cost, with the assistance of reliable contractors if he prefers. Submit the work to competitive bids, the contractor bidding upon the percentage of cost for which he undertakes the work; add a provision that the upset or maximum fee shall be restricted to the percentage bid applied to the chief engineer's estimate already prepared and stated in the proposal, or use a cost-plus fixed sum system and bid competitively on the fixed sum.

"Important objections are that no measure is secured of the efficiency of the contractor, and that the ultimate cost of the work is problematical. Add to this the difficulties inherent to auditing. If the work is not to be let to the lowest responsible bidder, opportunity for political favoritism is provided. There are doubtless cases, however, where the advantages of this method would outweigh the disadvantages in municipal work.

"It is reasonable to assume that the lump-sum and the unit-price systems will continue in use; that the cost-plus system will be found to have much value in private contracts; and that in time engineers will develop a wise judgment as to the use to be made of each of the three systems."

Beyond what is stated above, the present speaker desires to add a discussion prepared for this meeting before referring to the material quoted above, and which does not materially repeat or interfere with it.

The cost-plus system undoubtedly has great value. It, no doubt, will have greater use in future than it has had in the past; the conditions created by the war led to a very extensive use of this form of contract. Because it was very successful in many cases under the conditions existing, it does not follow that under different conditions it should be considered as a panacea for all evils which have existed in contract letting.

The cost-plus contract is specially adapted to a rush job. The contractor, if he is keen, is interested more in his profit for the year than in his profit for a single job. Very many of the war contracts were large contracts, and the contractor was insured of as large a profit as would under other systems ordinarily fall to his lot for the same length of time; generally larger. Whether we, as engineers, have always thought so or not, many contractors are human in the best sense, and were as ready as the " dollar-per-year " men to help win the war. No doubt there were other contractors sensitive mainly to the profit, but these did not positively secure the success of the system, for success must be admitted.

There were features of the cost-plus contract which were not commendable. Under the conditions of war work, the efficient small contractor was largely eliminated, — necessarily perhaps. The tendency was towards centralization in large concerns which kept the work within their own organizations, without subletting.

Again, how much was the difficulty of high wages accelerated by this system, which caused contractors, under the conditions, to pay whatever was necessary to secure the results, which it was their unquestioned duty to secure? It is unfortunate that such a necessity existed. Yet the work was done, and the war more promptly ended in victory, rather than in defeat or carnage long drawn out.

One of the good results from the use of this system (under conditions existing) has been that the engineers and contractors have found it easy to realize that they were working together for a common end: and distrust largely vanished. This gain ought never to be altogether lost. The conditions, however, were responsible for this good result to a greater extent, probably, than was the form of contract.

In the long run, the nature of the engineer and the nature of the contractor will not be revolutionized by changing the form of contract. The possibility of squabbles is not eliminated by it. If the contractor takes work in expectation of speedy completion, and delays occur, he is in reality aggrieved.

If work is added which is not " extra work " properly within the contract, but outside of the contract, will the contractor be expected to do this within his upset contract profit? The opportunity for a lawsuit is not eliminated. If material is furnished from a distance, and the engineer says it is unsatisfactory, who stands the loss? Has the contractor bought the material judiciously, or from his best friend?

If the engineer wants to "skin" the contractor, or if the contractor and his friends are grafters, will the form of contract make it impossible to wrong one side or the other?

What is to be done in our larger municipalities, where laws have seemed necessary to prevent graft in awarding contracts, if a cost-plus system is adopted? Shall competitive bidding go by the board? What will competitive bidding mean if no restriction is placed upon the final upset price?

It is the opinion of the speaker that where plans can be fully completed in advance, so that the work is definite, and in times where labor and material prices are reasonably stable, and no special elements of risk are present other than the weather, a lump-sum contract will often prove more satisfactory to both contractor and owner. This would apply somewhat definitely to mill buildings or factories.

Where the quality of material is well known but the exact amount less certain, and where no special elements of risk exist, a unit-price system is indicated, and will probably be more satisfactory to contractor and owner. Laying water pipes, building sewers or reservoirs, grading, are specific examples. In each of these cases the owner knows, within reasonable limits, the cost before starting work.

Wherever, in connection with the lump-sum or the unit-price cases referred to above, there are serious elements of risk, as in the foundations of a mill, or where there is a probability of quicksand in an excavation, or any other serious element of risk, it may often be wise to let a limited part of work on the cost-plus basis, while the greater part of the construction is let either as lump-sum or unit-price, in substantial harmony with previous practice in work of a similar sort. In the immediate present, when labor and material costs are altogether uncertain, the argument for the cost-plus system is usually strong and in many cases convincing.

To the contrary, in small contracts the cost of auditing, and its inconvenience, constitute a strong argument against the cost-plus system. There are many private contracts let to-day, however, on the cost-plus basis, where no attempt is made to audit accounts, because the contractor is well known and entirely trusted; the contract is let, not under wide competition, but to contractors of reputation who value their reputation.

It is the opinion of the writer that, as sure as conditions become stabilized, the majority of contracts will be largely let under lump-sum or unit-price systems as heretofore, but that the cost-plus system will have a considerably increased use, partly for the whole contract, but also for parts of contracts where the risk ought not to be borne by the contractor.

The inquiry seems to be pertinent, Will the cost-plus system increase or decrease the cost of the work, not its price? The cost in its final analysis is a labor cost. The cost of labor will be increased at least by auditing costs, and it is probable that the efficiency of labor will be less under the cost-plus system.

In the speaker's experience, laborers were known to work with greater vigor as the contractor hove in sight. From that cause, contractors did simple work more cheaply than the city forces doing similar work. The question, whether under present conditions the average laborer will work with special vigor under any circumstances, appears to interfere slightly with the above prognosis.

I couldn't help thinking that the contract which Colonel Gow had to deal with was a contract which illustrated the cost-plus basis to the very best advantage. I am not sufficiently familiar with the contractor to be sure about it, but I assume that the contract, in the profit that it yielded to him, was a contract rather better than he had previously had. That tended to make things run smoothly. The matter of patriotism, I take it, was not altogether lacking in that contract. The powerful arm of the Government, in the regulating of matters which would easily admit of dispute, was another element. Aside from that, I believe that even disregarding the personality of the Government official in charge, his experience as an engineer and contractor, both, made it more possible to bring about results without confusion, and more satisfactorily to everybody, than would ordinarily result in a contract of that sort. I say that came about aside from the matter of personality, which certainly ought not to be neglected.

The editor of the *Railroad Gazette* once stated that one of the advantages of an engineer's education was that it enabled him to look facts in the face. It is very pleasant to hear people pass bouquets to engineers with relation to the fees they collect, and somehow one gets the idea that the engineer is a pretty good fellow; until you strike the fact that he has connection with contractors in enforcing contracts. As it has been suggested that engineers use a cost-plus system in the fees that they charge their clients, let's look the facts in the face. There has never, so far as I know, been any necessity for the passage of laws regulating that feature, but in nearly every municipality there has been found the necessity for laws regulating the letting of contracts for municipal work, and we all know that there have been plenty of abuses, and the case of the engineer, who, I think, has as good a reputation on the average as even the judges, is not to be confounded with the case of the contractor who is dealing with municipalities which have become very corrupt. I think that no one will take issue with me as to the fact that in Boston there have, at times, been serious abuses in contract letting. While there has been some disagreement of opinion, especially as to the arbitration clause, yet, with relation to the general point of view advanced, as to the attitude of the courts, as evidenced by the Brooklyn dry-dock case, I believe there are other cases quite as substantial, in quite the same direction, and I don't quite see how I can get up an argument on this point, although it may seem that I ought to.

I believe that is the attitude the contractor absolutely should take. I didn't intend my remarks to indicate that contractors are a set of rascals. My experience is to the contrary. I have had to administer work where the difficulties were very serious and where the contractor apparently was not anxious to do the work to my satisfaction; but, take it in the large, you make a great mistake if you assume that the contractor is otherwise than a good square fellow. With a very large percentage you will find he is all right if you treat him right, but it certainly is the contractor's duty to know his engineer, and bid on his work or refuse to bid on his work, as some contractors do, if the engineer happens to be a man of whom they don't approve. In all private work the engineer or owner ought to have the same privilege — and does in private work generally — of excluding or refusing contractors of whom he doesn't approve.

Frank W. Hodgdon.* — I personally have had but little experience with the cost-plus system, other than extra work under contract. The greatest trouble I have found in that scheme is to determine what are costs. The labor costs, and costs of materials which you can purchase, are readily determined. A part of my work has been such that a very considerable if not the larger part of the costs has been plant rentals, and when we come to plant rentals — for plant so large and expensive that it is impracticable to purchase it for the job and sell it at its termination, such as dredges, scows, locomotives, steam shovels, etc. — we've got a very wide question to determine in the matter of costs. These rentals have been the greatest stumbling-block that I have seen in this cost-plus contract. I believe that the unit price is about as good a method of contract as you can get when things are in fairly stable condition. Of course, in recent years it has been very difficult to get any real costs either for labor or materials, in advance, which would last for the duration of the contract, and for that reason the cost-plus system, modified as it has been by the Government, seems to me to be a very good way of carrying on the work — practically the only way that was reasonable and fair to the contractor. But when it comes to reasonably settled conditions with the class of work I have been acquainted with, plant rentals are a big stumbling-block for any cost-plus work.

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* Engineer, Massachusetts Commission on Waterways and Public Lands, State House, Boston, Mass.

Speaking about the question of arbitration and increased cost to the contractor, — I have had a number of cases of contracts on the unit-price and lump-sum basis, where the contractor, although not a gambler, has bid an apparently very low price and got the job. In such cases the contractor is an intelligent man with a scheme in his head by which he thinks that he can do a certain portion of the work with half the amount or in a much shorter length of time than others, and he goes ahead and uses his scheme and makes a good thing of it. Now, if you are going to arbitrate the losses you must arbitrate the gains, and reduce the cost of the contract by the price of his brains in changing the method. The great desirability of the unit-price or lump-sum contract is that the contractor can use his brains, and he can make money where another fellow might lose. I had a case just come up where a certain work was bid upon by three parties at practically the same prices. The fourth party said that the prices were perfectly proper ones but that he had a scheme by which he could do the work cheaper — at about three quarters of their prices; that he could do it his way and make money — and I think he can, from what he told me.

CHARLES R. GOW.* — I expressed about all that I had to say on this subject at a previous meeting, but some additional thoughts have occurred to me in the light of what Mr. Allen and Mr. Hodgdon have just said.

The question of cost of necessary accounting work has been raised a great many times by various parties interested in this subject, and it seems to me to be readily settled by the consideration that the accounting has to be done and paid for by some one in any event. If the owner doesn't do it, the contractor must; and in that event it is presumably charged as part of the contractor's price for doing the work. For those owners not having an accounting force available in their own organization, it would seem to be an entirely simple matter to turn the work over to properly qualified certified public accountants, who would render the necessary reports to the owner. By such a method the accounting work could properly be done as cheaply, or more so, as if included by the contractor under his lump-sum bid, and would give to the owner all the protection as to this feature which he requires.

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* Charles R. Gow Co., 166 Devonshire Street, Boston, Mass.

The suggestion made by Professor Allen, that it would be very difficult for a contractor to carry on both types of work — that is, the lump-sum form and the cost-plus form — at the same time, is a pertinent criticism, and it seems to me to resolve itself down to this, — that no contractor should attempt to carry on both classes of contract work at the same time, because it is obvious that as human nature is at present constituted, — and contractors are human, — if he had both types of work in progress simultaneously there would exist a strong incentive to give consideration in economic questions, to the lump-sum contract, on which he had most to gain thereby; and I should certainly agree that if the cost-plus-a-fee contract is to become at all general, it must be taken up as an exclusive form of contract by certain contracting concerns, otherwise difficulties will probably result, as pointed out.

The possibility of applying the cost-plus form of contract to public work presents an extremely difficult problem, because the same spirit of disinterestedness in the selection of the contractor and in awarding the contract, which exists in the case of a private owner, is often lacking in such cases; it would seem that a special or modified form of cost-plus contract, if any, would have to be worked out, to apply to contracts of a public nature. Very few reputable public officials will wish to be burdened with the responsibility of picking out a contractor for a given piece of work, because criticism and unkind allegations are almost sure to follow, regardless of their honesty of intent. Nevertheless, it is possible such a form of contract might be modified so as to permit of its application even to work of this character if drawn on a basis whereby the contractors bid on the estimated cost of the proposed work and also the fee which they would be willing to accept, thus maintaining the competitive features. However, such a course would open the door to the incompetent bidder with his low proposal, which could not easily be rejected without assuming danger of criticism.

The question of the contractor's incentive to do his best work under the cost-plus basis seems to me to revolve itself down entirely to the personality of the contractor. The benefit, it has seemed to me, to the owner — or perhaps I should say, the portion of the benefit — would come from availing himself of a contracting concern which has an established reputation, and the establishing of that reputation is bound to be an incentive to the contractor. In other words, as I think I pointed out last summer in a previous discussion on this subject, the average contractor as well as owner will have to undergo an entire change of viewpoint with respect to their responsibilities under the new form of contract. The contractor must be brought to realize that to be successful he must prove to the owner his capabilities, both as a contractor and as an economist, and if he fails in either one of these requirements he lessens his chance of securing additional work. I believe this is the basis of the present operation of a great many concerns that are following the cost-plus method of doing work exclusively. That is, they are attempting to build up a reputation for economy, for speed and progress and general aptitude for their class of work, and they are succeeding admirably in a great many cases, to such extent that owners are now soliciting them instead of as formerly when the contractor was obliged to solicit the owner. That is the only incentive, but it is a strong one; and if some such inducement to effort does not exist we may as well drop all further consideration of this form of contract.

The possible status of small and untried contracting concerns under the proposed form of contract procedure undoubtedly does demand some consideration. Whether the more or less general adoption of the cost-plus-a-fee contract will result in squeezing out and eliminating the small contractors who might otherwise be competent is a question. It seems to me that that will ultimately be taken care of by their utilization as subcontractors, until such time as they in turn establish a reputation which will warrant their receiving consideration as general contractors.

The apprehension of Professor Allen that laborers be more apt to demand increases in wages under this type of contract is not necessarily well founded. During the war wages were fixed for Government work by a labor board with headquarters at Washington, D. C., and they were changed only after presentation of the very strongest evidence that the prevailing rate for similar trades in the neighborhood where the work was being done, had been increased. In other words, it was impossible to obtain an increase in any labor wage until the demand had been passed upon by this war board appointed by the President and charged with the duty of compiling rates of the various classes of labor in any community, and only such rates as were approved by this board could be paid. The notion, more or less broadcast, that excessive rates were paid, is due to the fact that on account of the rush conditions very long shifts were necessary, and where union conditions prevailed the requirements of the unions as to payment for overtime often made the weekly pay appear unreasonably large. For example, when the work was carried on seven days a week, including holidays, Saturdays and Sundays, and the like, at the prevailing union scale, a very high average rate results. The scale of hourly rates paid, however, did not vary from local standards.

The difficulties foreseen by Professor Allen with regard to possible variation in the amount of work to be done and adjustments therefor, was not a serious obstacle in the carrying on of Government work, because the contract specifically provided that the contractor's employment under the contract covered all of the work to be done on the given project, regardless of how much or how little, — and he was paid on a sliding scale in proportion to the amount actually done. If he did more than originally anticipated he received more, and if less, he received less; but as this amount increased the percentage decreased, and the fixed maximum fee was not affected.

Mr. Hodgdon has put his finger on one of the difficulties encountered, and that is the question of plant rental. It is a very troublesome and perplexing feature of the cost-plus contract, and one that gave us considerable concern in the prosecution of the Army Base work. A price list was established in this contract which was intended to cover every class of equipment which might be used, and a range of prices was fixed covering the probable scale of rates at which the particular equipment could be hired. Nevertheless, difficulties were inevitable, and so a certain loophole was left in the contract, whereby the contracting officer could vary from the scale, if necessary, — and it was necessary in many instances. Very often a certain type of equipment which was badly needed was not obtainable except at higher rates than those allowed, and the law of supply and demand had, therefore, to govern. If the owner of the needed equipment could obtain a higher rental somewhere else, naturally he preferred not to let it to the Government for less. After equipment was rented, the further question arose as to repair and upkeep. We made it a practice to inspect each piece of equipment when it arrived on the work, and determine whether or not it was in satisfactory working condition. If reported not in such condition, instructions were given that it should be put in satisfactory condition by the owner, before being put to work. Occasionally defects would not become apparent until the machinery was in use, and frequently repairs amounting almost to complete rebuilding were necessary if it were to be continued at work. Oftentimes further repair work was necessary, returning equipment in a condition satisfactory to its owner. However, I believe that this feature is not necessarily a vital one, as affecting the character of the contract, because it can be modified and presumably improved by requiring that the upkeep or replacement repairs on the equipment shall be borne entirely by the owner, in which case, of course, he would be entitled to a higher rate of rental than if the user paid for repairs.

I wish to make myself entirely clear as to my attitude toward this type of contract. From the experience which we had at the Army Base, I was very much pleased with its apparent adaptability not only to that work but to any work which needed to be done in a hurry and where time could be saved by avoiding the usual preliminaries that require a considerable period of preparation. I was also gratified with the attitude of the contractors, once they had entered into the spirit of the thing. It made me feel optimistic with regard to the possibility of applying it more or less generally, because I think that the average owner will agree that there is no reason why he should pay either excessive prices for the work to be done or why he should get it done at a ridiculously low price. In other words, the result of the effort is for the benefit of the owner, and as a basic principle it seems that he should be willing to pay the fair cost of the work, whatever that may be. Under this form of contract, if carefully carried out by both parties, he does pay the fair cost and no more. He pays for all the uncertainties, as it seems to me he properly should. Under the lump-sum basis the owner, generally speaking, attempts to settle all uncertainties on the contractor. I do not mean to say that this practice in itself is unfair, because the lump-sum contractor accepts the burden knowing it to exist, but it does not seem to me on sound business principles it is just that the unknown quantities and responsibilities should be placed upon the party who does not benefit therefrom, except as he may be a shrewd guesser or, as some might say, a clever gambler. Under the cost-plus system, uncertainties are placed where they properly belong.

From the standpoint of personal interest, I shall regret seeing the general adoption of the cost-plus form of contract, but, nevertheless, I feel convinced that the tendency during the next few years is going to be largely toward its adoption by private owners. Whether or not it can be modified so as to apply to public work I am not at all certain, and if it is, it must be in some modified form that will eliminate the danger, let us say, of suspicious accusation. I believe if I were a public official I should hesitate a long time to apply the cost-plus principle to public contracts without some safeguarding modifications which would eliminate the danger of allegations of favoritism or dishonest intent.

One or two additional thoughts have occurred to me in the light of what the various speakers have said to-night. One is with regard to the owner's position under the lump-sum form of contract. I think the chief advantage claimed for the lump-sum form is the fact that the owner is confronted with more or less of a certainty as to what the work is going to cost, as against the uncertainty of the cost-plus contract. I do not feel that this is a specially valid argument from the fact that the owner under the lump-sum form does not know what his final cost is to be until after all possible claims and litigation are settled, and he may often be very much shocked by the results.

Professor Allen possibly will not agree in all respects with what I am going to say with regard to the legal aspects of contracts, but I believe the tendency of the courts to-day is toward a broader view in equity, of the contractural relations. A recent decision of the United States Supreme Court, for example, is the case of the Brooklyn Dry-dock, which was quoted at more or less length about a year ago, in the engineering press, which seems to establish the principle that, in case of disclaimer by the owner for responsibility for certain unknown conditions and his attempt to place the burden of the investigation upon the contractor, in making his bid, there are certain responsibilities which he cannot so evade. In this particular instance a sewer which required relocation collapsed in a storm, and flooded the excavation. It developed upon investigation that the outlet sewer, into which this particular sewer emptied, was partially obstructed by the presence of a brick bulkhead, apparently unknown to either party up to that time. The contractor served notice on the owner — the United States Government — that he must remove the bulkhead, repair the sewer and take measures to make it safe against a similar accident, or he would refuse to go on with the work. The Government denied his claim, and he abandoned the work. The determination of the Supreme Court was to the effect that these sewers were all upon the owner's property; that he either knew or had a right to know of the existence of the obstruction in the sewer, and such being the case he could not pass the burden on to the contractor. An accounting was allowed the contractor for the work he had done up to that time, with a reasonable profit.

There have been a number of similar instances. Recently, in this city, conditions proved to be different from those shown on a plan of borings, and it was found that the responsibility for the misinformation was occasioned by the mistaken judgment of the engineer in making certain notations on the plan. In this case the Master who sat upon the case for the United States Court ruled that the contractor was entitled to damages, not for additional expense but for the additional amount he would presumably have bid had the true conditions been properly shown on the plans.

All of this goes to show that the lump-sum bid does not necessarily imply certainty as to the ultimate cost of the work.

It has been the practice in the past for engineers to take engineering work at times on a lump-sum basis, although I believe now, by general agreement as to the propriety of the case, it is almost universally awarded on some other basis which approximates the cost-plus method, or at least where the uncertainties of the work are not carried by the engineer. No one, I think, will question the justice of that form of arrangement, and no one thinks because the engineer is reimbursed by the cost-plus percentage he necessarily takes occasion to load the job down with unnecessary elements of design or a superabundance of men; and there is no reason, in my judgment, why the same situation could not prevail with regard to contractors. It would simply mean the conversion of the contractor from his previous point of view to the new one, which is that he no longer acts in an independent capacity entirely for his own benefit, but that he is engaged as an expert agent of the owner and that the benefit which he brings to the owner will measure his value as a contractor.

Because lump-sum contracts are so overburdened as they are to-day, with what seems to be unfair requirements and limitations, there is a moral question raised as to the proper responsibility of the contractor always to carry the expense of entirely unforeseen conditions. It has been suggested that the contractor should have recourse to some court of arbitration to determine whether or not the particular difficulty or issue is a matter which the contractor should have foreseen and properly taken into account in making his bid. A practice has been common for some years, particularly among engineers in private practice, who from time to time may have had unfortunate experiences growing out of loopholes unintentionally left in a contract, to plug such holes by the introduction of an additional provision, usually of a blanket nature, which will prevent any similar recurrence. Having thus specifically provided against any claim along those general lines, the engineer is precluded from listening to any complaint of the contractor, since to do so would be to set aside a specific clause in the contract. In this manner the scrupulous contractor may often suffer from the previous acts of the less scrupulous one, whose acts caused the original insertion of the drastic clause.

David Harum, I believe, said it was a good thing for a dog to have some fleas, as otherwise he wouldn't know he was a dog. So if the contractor does not suffer losses sometimes, he will not realize he is a contractor. He does not ask to have his fair losses arbitrated, but he does ask to obtain relief from these onerous clauses which are intended to prevent unscrupulous action, but should not operate against the worthy and honest contractor.

CHARLES M. SPOFFORD.* — Previous speakers have stated that the character of the work to be done is of importance in determining the availability of a cost-plus form of contract, and that the cost-plus contract, as generally used, is not one that is ordinarily applicable to the construction of public works owing to the absence of competitive features in such a contract. On the other hand, in the case of emergency construction work, such as the recent war projects of the Government, the cost-plus contract is especially appropriate as it permits the immediate commencement of construction.

There is another element in the character of work which has not been pointed out this evening but which has an important bearing upon the form of contract to be adopted, that is, the necessity of the work. For example, it may happen that a railroad must replace a bridge regardless of its cost in order to maintain service. Under such conditions, no special advantage accrues to the owner in knowing in advance the cost of construction, and a cost-plus contract is eminently appropriate. On the other hand, the project may be under consideration by bankers who will not endorse it without having a definite bid from reputable contractors to construct the work at a fixed figure, such a decision eliminating the cost-plus form of contract as ordinarily written. In this connection, it may be noted that the head of a large banking firm in this city recently told the speaker that if his firm should ever undertake to finance a project to be done on the cost-plus basis, he would want to resign from the firm.

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The experience of the speaker's firm with the cost-plus form of contract has been satisfactory so far as the character of the construction is concerned. As to the cost of the work, however, as compared with that of similar work done under a lump-sum contract, the speaker's information is insufficient to venture an opinion. He does know, however, that the cost of engineering will be greater for a cost-plus job than for a lump-sum contract, provided the engineer is required to approve the bills in addition to his other duties. This difference may easily amount to an appreciable percentage of the total cost of the work. In consequence, the cost-plus form of construction must show to the owner an appreciable saving over the cost of a lump-sum job in order that the ultimate cost of the two jobs to the owner may be the same; that is, unless the owner is willing to accept the work of the contractor without approval of his bills by the engineer.

There is one form of cost-plus contract which has not yet been mentioned, namely, that where an upset figure is given, which the contractor guarantees not to exceed. The speaker knows two or three construction jobs which have been carried through recently on this basis. Such a contract has the advantage of giving the owner a definite knowledge of the maximum cost of the construction, and is better in this respect than a lump-sum contract, owing to the probable addition of some charges for extra work in the latter case.

A point which has been brought up by one of the speakers is that it may be impossible for newly organized firms to get work on a cost-plus basis, inasmuch as the only competitive element in contracts let on such a basis is the reputation of the organization for efficient and satisfactory work. While admitting that it may be difficult for firms without a reputation to obtain such work, the speaker knows that it is not impossible, because of his association with a recently established organization which has taken a considerable amount of work on the cost-plus basis. In this case, the heads of the company were well-known, but the organization itself had no construction record.

R. A. HALE.* — I think there are a great many reasons for considering either of these contracts as being advantageous in certain cases. As Professor Allen says, in case of building a mill, where you go out into the field and everything is perfectly clear, there is no question but that the lump-sum method can be used with advantage. But where you have to do with raceways, cofferdams, etc., the element of uncertainty always comes in, in which case the cost-plus contract would seem to be better. This was the case in Lawrence, and all the large mills were built on the cost-plus basis. One of the large corporations which has been very successful has had all of its work done for years on a cost-plus method. It has a contractor who has been there for many years and who does things in a first-class manner, and no doubt, where uncertainties come in, has its work done cheaper than it would on any lump-sum method.

We also have an example in Lawrence of a mixed form of contract, combining both the lump-sum and cost-plus contract. This is the Central Bridge, which has just been completed. The first intention was to award the contract on the lump-sum basis, but owing to some error and legal complication the contractors were finally allowed to build it on the cost-plus basis up to the springing-line of the arches, and above that on a unit-price basis. That brought all the uncertainty on to the City, and the contractors certainly took advantage of it in every way. For example, the water in July, 1917, rose 10 ft. higher than it had for twenty years, and, of course, the expense all fell on the City. The work was not carried on to advantage. I do not think that the contractor was especially efficient, and this made the cost very excessive, so that, although the work was estimated to cost about $400 000, it has cost pretty nearly $1 000 000.

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* Principal Assistant Engineer, Essex Water Power Company, Lawrence, Mass.

I think, with perhaps a different contractor, one who was more familiar with that type of work, the cost might have been very much reduced.

E. F. LARNED.* — I think there are conditions prevailing to-day that must be recognized to be very greatly in favor of a cost-plus form of contract. It has become exceedingly difficult to get the usual number of proposals on a lump-sum basis, for work of a more or less hazardous nature, because of the uncertainties attending work these days. Labor is not a fixed commodity or quantity any longer. The contractor not only finds a shortage of labor, but he finds a constantly changing condition, which makes a careful, conservative estimate of cost impossible. Further, an element has been introduced into the cost of work that nobody can estimate, and that is the cost of delay. Delay to-day means something entirely different from what it did a few years ago. Previously, for instance, if the work couldn't be pursued on a certain day the men would be informed, "We are not going to work to-day. Come around to-morrow." But now the contractor cannot do that; if he did the men would not appear the next day, having gone to work somewhere else. The men must be kept on the pay-roll and assured of a pretty good sum at the end of the week, or they will go elsewhere. I think one step in advance might be taken on the lump-sum contract if that were not made so burdensome and sometimes so perfectly unfair to the contractor. The entire responsibility should not be put upon him. The engineer is forced, by the nature of the work, into the position of being not only the sole judge of the character of the work and of the methods of its conduct, but also arbiter in case any disputes arise. This is a most unfortunate position to force engineers into.

Another element is the more or less speculative nature of all contracts. Uncertainties always exist, and although the contractor takes them into account they sometimes prove to be very exceptional and involve a very high cost in their solution, and yet the contractor has no redress. It does not seem entirely right that the contractor should be made to carry all that burden. If he is efficient he can overcome the difficulty when it arises, but he cannot foresee the difficulty, and its cost should not fall upon him unless he has provided for it. If the form of contract were not so drastic, contractors would feel more disposed to make, perhaps, lower competitive bids, because they would then feel that in case of any unusual condition arising that called for arbitration, the matter would be settled on its merits, but now they feel that such matters demand litigation and they have found from bitter experience that litigation is expensive.

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* Civil Engineer, 79 Milk Street, Boston, Mass.

I think, therefore, that some form of arbitration clause should be introduced in all lump-sum contracts, and that while the engineer in charge of the work should be closely identified with the arbitration I think he should not be the arbiter. I think that this should be taken entirely out of his hands. The board of arbitration ought to be constituted of outside men, and while the engineer would be appealed to on any doubtful points, just as would the contractor, he should not be the sole judge, because it is difficult for the engineer to be totally unbiased by the connections that his position necessarily involves. He is employed by one party to the contract, and he primarily represents him, and it is the experience of almost everybody having to do with a great variety of work, that the contractor has a pretty slim chance, as a rule, unless he has a very, very clear case. He isn't given the benefit of the doubt. The case must be so apparent and clear that there can be no question about it.

LEONARD METCALF.* — I have been very much interested in the discussion to-night, because it seems to me it has given point to various things, especially to the change which conditions have undergone in the last decade or two, and which have had an influence on the method of letting contracts. We have to-day a very large number of contracting firms competent to handle large work admirably and with dispatch. This has broadened the point of view of the contractor; has changed the nature of his work; and has made it more of an administrative problem. To-day the work of the contractor is more of a profession than it was ten or twelve years ago; consequently we may look for better coöperation and better results than formerly.

I had the pleasure of serving with the committee in Washington which prepared the emergency contract which has been referred to, so I know the governing motives behind it. The one idea that I should like to emphasize with respect to its application — one to which Professor Allen has referred — is that it was essentially an *emergency* contract. The more the committee considered this question, the more it realized the unparalleled magnitude of the construction problem and the tremendous hazard element involved in it with soaring labor and material prices. So the only criticism — if it can be called criticism — that I would make of Professor Allen's statement, is that in the work to be done under the emergency contract in building the cantonments, it was felt that the hazard element, alone, might increase normal cost not only 5 or 10 per cent. but by percentages which might run to 30 per cent. or more in some cases. The principle of relieving the contractor of uncertainty and hazard was the only one which could be utilized to keep the cost of the hazard element within bounds. Of course the lack of time presented the most serious difficulty. Common prudence dictated the employment only of thoroughly competent and experienced contractors to do the work. Those two conditions — the time element and the responsibility element — immediately eliminated the small contractors, because it would have been absolutely impossible to handle work on any such scale by a centralized form of control from Washington, which would have been involved by subletting or dividing up the work among small contractors. The biggest, most experienced contractors had to be selected.

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I well remember that on some of the first recommendations to the Department, or to the Secretary of War, submitted for their approval or rejection, — approval, as it happened, — the statement was made that while other contractors had been suggested to us, they had never before done work of such magnitude, and that it was not thought wise to take any but men who had done work on a large scale, and that the commission on work that was done by subcontractors was a very much smaller element of cost than would have been involved by the hazard of pursuing the other course of action.

I feel very keenly the force of what Colonel Gow has said with regard to the attitude of the Commission. I feel sure that all the men who sat down to select contractors for the cantonment construction felt that their reputations might suffer later on as a result of political pressure and influence. Every man had honesty of purpose and sincere desire to further the best interests of the Government. It appeared safer to limit the work to contractors of wide experience, from whom the quickest results could be hoped; and I think, in retrospect, the action taken was a wise one. Mistakes were made, of course, but as a whole, reviewing the outcome of the effort and comparing it with the expenditure of millions by some of our cities, the results attained confirm the judgment of the Committee.

There was discussed at that time the expedient of letting men bid on the percentage for which they would do the work, but this idea was rejected, as it introduced the hazard element again, — because the inexperienced man was the very man who would have been likely to give the lowest bid.

I accentuate these facts to bring home to you the abnormal conditions and the emergency character of the work with which the Government was confronted. Of course the hazard element in conditions, labor or materials, may exist in other works and does exist in many classes of work, and to those jobs this form of contract is particularly well adapted.

Personally, I do not believe it is well adapted to or workable under our American municipal and political conditions. On the other hand, for private work or work of large corporations, it has advantage in some cases. There is a very strong feeling, among manufacturers especially, that they prefer to know beforehand, just what the work is to cost rather than to take the hazard of the cost-plus basis, and that they prefer to pay what is necessary to get that comparative certainty beforehand.

I have already spoken of the necessity for decentralizing such large work as this, which in itself implies thoroughly competent men to take charge of the work on individual jobs. For example, the cantonment work could not have been done nearly so promptly if all of the work had been planned at Washington. The work had to be done on the ground. Of course, general sketches were made and the interrelation of the different departments was determined from Washington. The work was controlled from Washington, but the work of designing and building was done essentially on the ground.

The most serious difficulty with this form of contract, as I viewed it, was a purely psychological one. Reference has been made to it, I think. It is the effect upon the workmen themselves. It does have an effect upon the workmen to know that the owner is doing the work on the cost-plus basis, and that the contractor's compensation is not dependent upon the skill and efficiency with which the work is done. Now, under conditions where there is great competition for the positions, this may not have so serious an effect as it has under those conditions where there is a shortage of labor, because that makes the point of view of the individual more independent.

The accounting may be done by two general methods. That was also a matter of a great deal of concern to the Committee at Washington. It was the belief of the Committee that the most effective way to do it was to have but one body of accountants, and that the large contracting firms already had the necessary organizations which could be used more advantageously than to build up a new corps, provided that the Government did enough accounting to thoroughly check the results. The books were to be open always to the Government. The other scheme — to have two full sets of accountants, the one the Government's, the other the contractor's—involved much more serious duplication of effort and cost. An effort was made to adopt the first. It was found impracticable. Of course the Comptroller of the Treasury wasn't ready to audit the accounts until his men had approved them on the ground. The Committee realized the danger of delay in the settlement of accounts, usual to Government contracts. So the Committee strove to have the Comptroller appoint representatives at the various important construction jobs to settle the bills monthly, finally, in a way that would enable him to satisfactorily account for the funds. But that proved impossible. The result was that a large new organization was built up, with methods not born of contractors' experience, but of accountants' experience, which were extremely burdensome. The difficulties were eventually righted through the pressure of the situation. Delays to the work resulted, and when those delays were brought home to the accountants they realized that they must give way. They were then ready to make use of the experience of the contractors in developing methods which were adequate and which were easy of application, which led to more expeditious results.

I want, too, to bring home the difficulty of building up a large organization and of developing good team play. That, of course, is the one thing you must get, and you actually get it when you employ a competent concern.

I think the previous speakers have been quite right in their point of view that the contractor's reputation is his best asset, and that millions of dollars' worth of work are being assigned daily purely on personnel. It is also interesting to see how certain concerns or groups of men have come up, gone backward and come up again.

So much for the general statement of the cantonment work.

I promised Mr. E. S. Dorr, of the Sewer Department in Boston, to present for him a new form of contract, which is a modification of the cost-plus contract, which he prepared for city use and in which he has been very much interested. I am exceedingly sorry that he is not here himself to present it, but he is one of that splendid group of enthusiasts who have undertaken to maintain the arm of the law in Boston, and were not able to come to-night.

I also want to call your attention to another form of contract, published in *Contracting*, September 15, 1919, by Dr. J. A. L. Waddell, of Kansas City, in which he suggests the fixing of a certain price and the variation in the proportion of the return which shall go to the contractor or the individual, according as the final price is greater or less than that amount. It has merit, I think, in principle, but it seems to me it would be difficult of application for the very reason which Mr. Hodgdon has called your attention to, to-night. It gets back to cost accounting, which in many works is difficult.

I shall now read a letter which Mr. Dorr wrote to Mr. Thomas F. Bowes, to accompany his proposed contract:

Mr. Thos. F. Bowes,
Engineer in Charge:

Dear Sir, — I send you herewith a tentative draft of a competitive "cost-plus" contract; this is not a contract, but is a statement of the controlling features of one.

The Federal Government and private corporations during the war did vast amounts of work under cost-plus contracts. The reasons for adopting this form of contract were the great war exigency and the great uncertainty as to prices of materials and labor. With the exception of the war exigency these conditions continue and are likely to continue for an indefinite time in the future.

Under these conditions a contract, particularly for underground work, is a gambling rather than a business proposition, and is unfair both to the contractor and to the city (or state). It is unfair to the contractor because he may suffer on account of fluctuations in prices which no one can foresee.

It is unfair to the city because, to insure himself against such losses, the contractor must assume and bid the highest prices which may obtain during the life of his contract; the city therefore pays for risks which may not materialize.

Prices must decline at some time, but no one knows when. Under an item on lump-sum contract, if this decline occurs during the life of a contract, the city would not share in the saving; under a cost-plus contract, it would.

There are, therefore, valid reasons for the adoption of a form of cost-plus contract, provided one can be devised which is fair and cannot be abused.

For the use of a city or state, the contract must be competitive; this was not necessary for the Federal Government. It is also desirable to supply an incentive for economy (not apparent in the federal contracts), and for speed without sacrifice of economy, also not apparent in the federal contracts except through the natural desire of a contractor to finish quickly in order to get more contracts.

I have, therefore, formulated a contract containing these elements, viz., competition and incentive to economy and speed.

The reason for some provisions and percentage also requires brief explanation.

The difficulty in formulating a *competitive* cost-plus contract is in establishing a real and controlling relation between the bid and the payments for the work, which will also be fair to both parties. Competitive cost-plus contracts have been made in which the contractor was required to state his estimate of cost, and received in payment the actual cost of the work, plus a fee, and plus a bonus or minus a penalty, according to whether he had made the actual cost less or more than his estimate. This would work all right, provided the actual quantities correspond to the estimated quantities, but if they do not, the result is complicated. For instance, the actual cost might exceed the estimate due wholly to an excess of the actual over the estimated quantities, when at the same time the actual item cost had been made, through efficiency in the management, less than the estimated item cost.

By the provision for an itemized bid, and the provision for a " modified estimate," a complete means of correction is supplied. The modified estimate is the estimate which the contractor would have made in his proposal, had it been possible for him to have known beforehand just what the actual quantities would be. Bonuses and penalties are then figured upon the basis of the modified estimate, and not the original estimate, which is just.

The reasons for making the fee a percentage of the estimate, for making it as high as 15 per cent. and for fixing the percentage instead of having it bid, are as follows:

If the fee were made a lump sum, this sum would have to bear a percentile relation to the estimated cost; it is simpler to make it a percentage.

The size of the fee compared to the estimate makes but little difference to the contractor in making his bid; he is then making up a sum, called the " arbitrary sum," which is to be used in comparison of bids, and will try to keep it low, so as to secure the contract. If he concludes to reduce this sum, he would naturally do it by cutting down on the fee; he would keep the estimate high and the fee low, because a high estimate increases the chance for a bonus, and because the fee is the fund from which penalties are taken, and as soon as it is exhausted, he escapes control in a large measure. As the contract is framed, his only way of reducing the arbitrary sum is by reducing the estimate (and time); which reduces the amount although not the percentage of the fee. If the fee is reduced unduly in this manner the contractor has no grounds for complaint.

It should be observed that the modification of the fee is to be for precisely the same reason and in the same proportion as that of the estimate; it is a purely corrective measure. It is based upon changes in quantities only, and is not affected by efficiency or the lack of it.

The provision for bonuses and penalties covers the features of efficiency. The bonus of 75 per cent. of the saving on the modified estimate may appear to be large, but is essentially just, for if a contractor can save anything on an estimate made in competition he is entitled to the largest share of it. But there is another practical reason for making the bonus large. The weakness of a percentile contract is in the opportunity it offers for fraud by padding pay-rolls and double billing of materials; a large bonus minimizes this evil; it would not pay a contractor to risk his reputation for what little there would be in it for him.

The aim of the writer has been to devise a form of percentile contract which would attract able and reputable contractors, and would induce and compel each one to bid just about what he thought he, with his resources, could do, and then make good on it and better it if he could.

This is, of course, the ideal which we should strive to attain in formulating a contract.

Experience may show that some percentages can be changed with advantage, but I believe the general form will stand the test of use, and while not wholly fraud-proof (which is impossible) will be found to be fairer, more businesslike and less susceptible to abuse than any other now in general use.

Copy of federal contract enclosed for comparison.

Respectfully,

E. S. Dorr,
Office Engineer.

Outline of Proposed Competitive "Cost-Plus" Contract.

Proposal.

(*a*) The City shall furnish a list of the items of the work, substantially as in the present form of contract, including estimates of quantities of all kinds of lumber which it is intended to incorporate in the work or leave in, and including an itemized statement of the quantities of materials which the City will furnish with values of such materials. The contractor shall bid prices on all other items.

It is to be understood that the quantities stated in the proposal are assumed solely for the purposes hereinafter described in paragraphs (*b*), (*d*), (*e*), (*f*), (*g*), (*i*) and (*j*). The commissioner does not expressly or by implication agree that the actual amount of work will even approximately correspond therewith, but reserves the right to increase or diminish the amount of any class or portion of the work as he may deem necessary.

If the price of any item bid by the contractor, or the sum total of all the items, is obviously abnormally high or low, the commissioner reserves the right to reject the proposal.

If required so to do, the contractor shall furnish evidence satisfactory to the commissioner that he has ability and experience in this kind of work, and that he has sufficient capital and plant to enable him to prosecute the same successfully, and complete it *within* the time hereinafter stated by him; and the commissioner reserves the right to reject any or all proposals or to accept any proposal, should he deem it for the interest of the City so to do.

(*b*) The City shall compute, as a lump sum, the contractor's estimate of the total cost of the work, exclusive of his fee. This lump sum shall be made up by adding together the values of the items of the work (including the materials to be furnished by the City), reckoned at the prices stated by the City for materials furnished by it, and at the prices bid by the contractor for materials and labor furnished by him, in the proposal.

(*c*) The contractor shall state, in number of working days, the time required by him for the completion of the work.

(*d*) The contractor shall receive, as a lump sum, a fee as full compensation for his personal services and that of his organization, including profit and all general overhead expenses, except as hereinafter otherwise provided.

The fee shall be 15 per cent. of the contractor's estimate (unmodified), including the value of the materials to be furnished by the City. This sum shall be used as the fee for comparison of bids only; it may be modified for payment as hereinafter described.

Comparison of Bids.

(*e*) Bids will be compared on the basis of an arbitrary sum to be computed by adding together the three following sums:

1. The lump sum reckoned as above stated as the contractor's estimate of the cost of the work;
2. A sum obtained by calculating 1 per cent. per month (thirty days), or 1/30 of 1 per cent. per day of the "estimate" for the "time" stated by the contractor as required by him for the completion of the work;
3. The lump sum to be received by the contractor as his fee.

(*f*) This arbitrary sum will be calculated in the manner described above, from the bid of each contractor for the purpose of comparison of bids only, and the smallest sum so obtained shall be considered the lowest bid.

Modification of the Estimate.

(*g*) If the quantity in any item of work shall be found to exceed by more than 10 per cent. the amount of such work estimated and stated (as above), the estimate shall be increased, for the purpose of calculating bonuses and penalties (to be hereinafter described), by the amount of the cost to the contractor of such excess, reckoned at the item prices as stated in the proposal.

And if the quantity in any item of the work shall be found to be less by more than 10 per cent. than the amount estimated and stated (as above) the estimate shall be decreased for the same purpose and in the same manner as above described for an increase.

If the commissioner of public works shall order the contractor to perform "extra work," the contractor shall do such work to the satisfaction of the commissioner and in such manner as he shall direct, and the estimate shall be increased by the cost of such work as determined by the commissioner from the force accounts.

Modification of the Time.

(*h*) If the estimate shall be increased or decreased for the reason stated, the time shall be correspondingly increased or decreased by the same percentage in days that the increase or decrease in money bears to the original estimate, and for the same purpose. The time may be increased (in addition) by the commissioner of public works of the City, on account of inclement weather, or by delays caused by the City, or otherwise, for which the contractor is in no wise responsible.

Modification of the Fee.

(*i*) If any increase or decrease shall be made in the quantities, a corresponding increase or decrease shall be made in the fee, that is, the fee shall be increased or decreased by the same percentage of the fee that the increase or decrease in the cost of such quantities, reckoned as stated in the proposal, bears to the original estimate. Moreover, if an increase shall be made in the estimate on account of "extra work," a corresponding percentile increase shall be made in the fee, as in the case of an increase in the quantities.

The fee shall be increased by bonuses and decreased by penalties on economy in the cost and in the time of completion of the work as hereinafter described.

Bonus and Penalty for Economy in Cost.

(*j*) If the total cost of the work (exclusive of the fee) shall fall below the contractor's estimate, modified as above described, (*g*), he shall receive a bonus of 75 per cent. of the difference; and if the cost shall exceed such estimate the contractor shall suffer a penalty of 50 per cent. of the difference, such bonus of penalty being added to or subtracted from the modified fee (*i*).

Bonus and Penalty for Economy in Time.

(*k*) If the total time occupied by the contractor in doing the work, modified as above described, shall fall below the time estimated by him in his proposal, he shall receive a bonus of 3 per cent. per month (thirty days), 1/10 of 1 per cent. per day, of the estimate modified as above described, for the difference in time between the time estimated and the time used; and if the time used shall exceed the time estimated, he shall suffer a corresponding penalty calculated in the same manner, such bonus or penalty being added to or subtracted from the modified fee (*i*).

Payments.

(*l*) Payments for labor and materials shall be made monthly, for labor as shown by the pay rolls checked by the force accounts, and for materials as shown by receipted vouchers.

There shall be no partial payments on account of the contractor's fee.

The fee, modified as above described, shall be paid to the contractor upon the completion and acceptance of the work.

Approval of Cost of Materials.

(*m*) The contractor, before purchasing any material, shall submit to the commissioner a statement of the quantity and price of the material he intends to buy, and shall purchase only upon the commissioner's approval of quantity and price.

(*n*) The City may furnish, at any time, any materials other than those stated in the proposal; the cost of materials purchased by the City for said work, exclusive of all freight charges thereon, shall be included in the cost of the work for the purpose of reckoning the fee to the contractor and the modified estimate, but for no other purpose.

VICTOR H. CLARKE.* — I have been much interested in the discussions this evening. It has been one of my duties, since joining the forces of Stone & Webster, to read most of the articles which have come out regarding cost plus. Although I am opposed in every way to the lump-sum contract, or guaranteed-cost contract, — which I believe are identical in so far as the incentive is concerned, — following along the suggestion made as to the psychological effect on the workmen of any kind of cost-plus contract, I should like to tell of an article (I don't know how many of the members may have read the article) printed recently in one of the engineering papers, regarding a Canadian firm of engineers which awards work on the above-stated (guaranteed-cost) basis. They take the estimate of the successful contractor and award the work on, we will say, a 20 per cent. commission basis, with the provision that for every dollar expended on the job he must pay to the owners an amount equal to 10 per cent. of same. In other words, if the job costs what he estimates, he will receive 10 per cent. net on the job. But the idea is that the workmen on the job are told that for every dollar spent it is costing the contractor 10 per cent. Satisfactory results have been attained, and the contractor has been able to get the work out of the workmen. That is a psychological way of getting around this difficulty.

I was interested in the remarks about cost of the plant. We have had very little trouble in settling at the end of the job, on account of the plant cost. Of course, we usually recommend buying new equipment on a job, the work generally being of such size that it pays to buy new equipment, and the upkeep on such equipment is very small. If, however, second-hand equipment is asked for, this equipment is appraised by disinterested parties, and that is the price at which the job is charged, and when the job is over it is either sold to outside parties or we take it upon an appraised value, so that the job is charged with depreciation only. If the owners wish, we will rent equipment, but we have found almost invariably it is cheaper to buy and sell than it is to rent. We find second-hand equipment seldom pays on large jobs. We have had very little trouble, and the owners are entirely satisfied in this plant cost.

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* With Stone & Webster, 147 Milk Street, Boston.

The vice-president of the Westinghouse-Church-Kerr Company in an interview stated that when they first started out they undertook lump-sum work, and later on they took work on a percentage basis, or for a fixed fee, and frequently they would have several jobs going at the same time, some on lump sum, others on percentage, and still others on a fixed fee, but he used this very apt expression, — "We have abandoned competitive bidding and have agreed to work only for the client," — meaning that when they were on a lump-sum or guaranteed-cost basis they were working for themselves.

As I remarked when I first started, I am very much opposed to lump sum or guaranteed cost, for under those forms the contractor is working for himself. He is not able to give to the owner the entire benefit of his years of experience, because he is giving that to himself, whereas on the cost-plus basis he is able to give to the owner every bit of knowledge and experience he has gained through these years of contracting, and the minute he is limited to an upset price he is going to begin to work for himself. In other words, the contractor who is doing work on a lump-sum basis usually cares only to finish that job and bid again, whereas the man on a fixed-fee basis carries on his work so as to build again.

We are endeavoring to talk to our prospective clients not so much as contractors as we are as professional men. We are selling a service. We are not merchants, buying building materials and then selling a building. We are selling building service. If I may be permitted, I should like to bring out a little of our personal experience. The question has come up about making estimates for bankers. I was analyzing, the other day, some of the work we have done in the last few years, and I divided the work up into several groups, — hydroelectric work, steam-power work, government work and industries; and I found in the last four or five years we have done 26 jobs for industries — building work, we'll call it — for a total of about $30 000 000, and on three jobs our completed cost exceeded our estimated cost at an average overrun of 2.6 per cent., and we finished 23 jobs under our estimate at an average underrun of 3.6 per cent., which ordinarily would be accurate enough to permit anybody to finance their enterprise. With the average lump-sum bid that a banker would take in building an office building, the extras would amount to considerably more than that.

H. E. WHEELER.* — There is one feature of contract work which has not been dwelt on very thoroughly. It does not occur so much with engineer's specifications as it does with a certain class of architects who do not use a uniform contract. They will submit a set of specifications to a contractor so drastic in its provisions as not to leave the contractor even a mind of his own. I have seen a great many of these specifications which are conflicting and take away all the liberty of the contractor. They contain blanket clauses which will force the contractor into litigation to break them, or break the contractor. They will specify flatly what type of work is to be done and then cover themselves by blanket clauses which state that the work must conform to all local ordinances and also to the full intent and meaning of the specifications and plans, whether that meaning is clear or not. In some cases it would necessitate the contractor being a mind reader to know what the intent was. It also makes it necessary for the contractor to know absolutely all local ordinances governing in the region where the work is to be built. It seems to me that it should be the duty of the architect to know the regulations and embody them in his plans and specifications. I have known this to result seriously in a number of cases where the contractor had taken it for granted that the ordinances would not vary greatly from those where he was accustomed to doing business and afterwards found the law in that locality very drastic.

We had a case recently where the owner came to us with a set of plans and asked for an approximate estimate, giving the impression that he did not want a close figure, but some idea as to what the building would cost, indicating that he would be willing to do the work on a cost-plus basis. We gave him an estimate and after receiving it he wanted us to sign a contract for that amount. We refused more as a matter of principle than anything else, and told him that if he wanted us to sign for the work on a contract basis, we would have to increase our approximate price 5 per cent. We lost the contract, which we understood was let 3 per cent. lower than the approximate figure we gave. One trouble with contract work in the past, I have noticed, is the narrow-minded attitude of architects and engineers. The remedy for this trouble would lie in the fundamental education of the architects. I know several prominent architects and engineers who claim that until the contract is let they are agents of the owners, but after the contract is let they are agents of the contractors as well as of the owners, and feel it their duty to protect the contractor from an unreasonable demand, as well as their duty to protect the owners from faulty workmanship. If architects and engineers could more generally take this attitude, there would be less trouble in contract work, but the attitude of architects, generally, is that the contractor is guilty until he proves himself innocent, and then the architect refuses to give him a chance to prove his innocence.

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* With L. H. Shattuck, Inc., Manchester, N. H.

I have knowledge of a contract which has been used satisfactorily at several times, which is much on the same line as Mr. Dorr's, but not so complicated. It has to do with estimated cost with fixed percentage or fixed fee, and variable forfeiture for exceeding the estimated cost, of a percentage of the contractor's fee, and a bonus in percentage of the amount saved. For instance, a contractor takes a job for $100 000 plus 10 per cent. If he exceeds it by $5 000 his fee is to be reduced by a percentage of the excess. If he saves he gets a percentage of the amount saved. I know of that contract having worked very favorably a number of times. It has the feature of competitive bidding and awarding of contract on that basis, and then it gives the contractor an object to keep his cost down to increase the amount of his fee.

The psychological aspect of labor has been spoken of a number of times. Personally, my experience of labor in the last few years has been that the psychological aspect can be discounted, because under union conditions the question of psychology is lost sight of by the laboring man himself. As they have become strongly unionized and the cost of labor has gone up, their efficiency has decreased in inverse ratio.

P. A. SHAW.* — Until I went with the Shattuck Company I had always been an engineer in private work, and had done a great deal of municipal work also, and I think I can look at a contract from both sides. I think, as far as municipal work is concerned, the cost-plus contract must await the millennium. I think we must leave it to the cities to be satisfied with taking the lowest competitive bidder. On account of legal restrictions, we must leave the cities to be practiced on by the inefficient contractor until he is good enough to work for individuals.

We are working on the cost-plus basis to a considerable extent. It is purely and simply a basis of confidence. For instance, take one of the largest contracts which we have on the cost-plus basis. When we got the job we had an architect's picture and made an estimate of what it would probably cost, and before the architect had any dimensions we had the cellar foundations started. On another, we had simply one line around a blue print, and were told the general nature of the building. In that case we bid percentages, — that is, the contract was awarded on the basis of the estimated cost of the building and the least percentage of profit. It was a private job, however. If it had been a public job some ignorant person would probably have bid a ridiculous price and received the work.

The thing seems to me to boil right down to a proposition of professional service. We are working directly for the client on cost-plus work, and we have only one thing to lose, — and that is the most valuable thing we have, — our reputation. The contractor has his reputation to lose, and if he loses that he knows he will get no more cost-plus work.

As for the contractor's slighting cost-plus work and giving his best attention to the lump-sum, — we were working on both kinds of contract in the same city, the other day, and could get only one concrete mixer in time for some concreting on both jobs. Our superintendent said that the mixer must go to the cost-plus job, and that we must mix the other job by hand. So, if you are working to build up a reputation and keep a steady clientele, it isn't a question of slighting the cost-plus work, it is a question of slighting the contract work, which you have a perfect right to do, as work done at a disadvantage comes out of your pocket.

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* With L. H. Shattuck, Inc., Manchester, N. H.

In regard to plant rentals: we were asked to bid on a lump-sum fee that was to include the rentals. That was one party's way of getting around the rental proposition. He had previously let a contract to a contractor who had a miserable plant which had to be rebuilt at the cost of the job. We have only one large contract on the lump-sum basis, and in that case we have the arbitration clause. It states there shall be an arbitration board for any matter which comes into serious dispute. As for a contractor's starting in on the cost-plus work, it doesn't seem possible until he has made his reputation. He can bid on contract work and practice on municipalities until he has a reputation, and then go ahead on cost-plus work for individuals, which is much more satisfactory work.

James W. Rollins * (*by letter*). At the request of the Secretary, who furnished me with a copy of the discussions, I am writing out my views on the subject of contracts.

To state my "platform," I do not believe in any cost-plus or percentage contract, unless there is great uncertainty as to the work to be done, or the cost of labor or material.

Great prominence has been given to percentage contracts because under war conditions, and especially as to work done for the Government, they were the only practicable form to be used, where work has to be done regardless of cost. The Government work was honestly and reasonably done, though no real contractor would "stand for" the inefficiency of labor that had to be used on these jobs. When carpenters, so-called, may be "botch carpenters," barbers or grocery clerks, and come to the contractor as union men, the Government accepts them, but no contractor would. "Put on men" is the slogan, and men go on, whether or not they know what an auger is other than to describe it as a tool that you "turn round and round," or to whom a cross-cut saw is the same as a rip saw. It looks well to show one thousand men on reports as working, though five hundred good men would do more work.

Our corporation up to war times did practically no percentage or cost-plus work, and never sought for any. We were ready to gamble with our own money and brains, and take straight contracts; and in twenty years of work, which covered some of the most difficult work done in New England, — mainly water work, — our losses were very small, and our profits satisfactory. In my judgment, percentage work of any kind tends to laxity on the part of both the engineers and contractors.

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* Of Holbrook, Cabot & Rollins, 6 Beacon Street, Boston, Mass.

In straight contracts, the engineer must make his plans and specifications with great care, so that the contractor knows just what he has to bid on, whereas if the work is done on a percentage basis, he can start with indefinite plans and change anything at any time and at any place. And the contractor cannot feel the responsibility or interest in the work when he feels that plans may be changed or that the engineer or owner is liable to come around and tell him how to do the work; when the contractor, knowing that the engineer or owner thinks differently, but must pay the bill, changes his plans and does the work, probably at greater expense, in the way his clients want. In one large job we did on a percentage basis, the engineer took entire charge and neither our superintendent nor myself were asked or consulted about the ways or means; so our fee was paid for us for tool and plant only, and our experience went for naught.

Another fact that I have repeatedly noticed, is that when work has been done on a percentage basis, the engineers and inspectors have allowed material to be used, and work done, which they would immediately have condemned if the contractor had been responsible for it. There is a reason for this. In percentage work, theoretically, the engineer and his inspectors want the work expedited, and so if a pile is 12 in. instead of 14, or a foundation is an inch or two out of line, they let it go, rather than delay the work; whereas were it done by contract they would insist on exact compliance with specifications and plans, and let the contractor pocket the loss, and make up for lost time.

I cannot see any more satisfactory way for an owner to have his work done than under a suitable contract with complete plans, with the contract in the hands of the lowest responsible bidder. There is no excuse to offer if work, either public or private, is awarded to an irresponsible bidder or to one without proper experience; and it is no justification to an engineer to do work on a percentage basis from fear that a poor contractor will get the job, when he has or should have the power to throw all such men out.

Percentage work can never be used for public work except in extreme cases, and, in my judgment, only in cases where work is indefinite or where the owner doesn't care for cost, or where the engineer thinks it easier to make his plans after the work is done.

A contractor is successful only as he makes money, and to do this he must use all his brains and resources to meet the demands of his work. He is alert to study all conditions, acquaint himself with what other men are doing, of the best plant and appliances available. The better he does all this the more money he legitimately makes by reducing the cost of the work. There is not this incentive when work is done on a percentage basis, for on that class of work cost does not come in, and but few engineers and almost no owners know whether the cost of the percentage work is low or high, and all they do know is that the work goes along well and the contractors are honest men and good fellows.

As an illustration of Government war contracts: The Navy Department asked for bids on piers in Boston, and got one bid of $500 000. This bid was thrown out and new ones asked for. I told one of the Government representatives that we would do the work on the same basis as we were doing the Army Base work, and my judgment was that the work would cost $300 000. The Navy Department would not do percentage work, so we made a bid of $440 000 and were the lowest of three bidders. We didn't get the job, because the money appropriated was not enough.

Any man who does only what he plans to do, is a failure. He must do better than he planned. So with contracting, it's a glorious game for a true sport; to be given a contract of great difficulty; to plan how he will do the work at a given price; then, as he does the work, to find some better and cheaper way; to beat Nature and the elements at their own game, and finish the work with a greater profit than he figured. Is it not reasonable to think a contractor plays the game better, on the above basis, than one who takes a contract with a fixed low percentage? He has no boss to tell him what to do, or to find fault with him if something goes wrong; and if he wins out the glory and money are his. To me that's the game — real contracting; any man with a reasonable amount of brains can do most anything *in time*, if some one else will pay the bill; but there is no sport in that kind of work!

If some of the contractors who do practically only percentage work would give us their experience in bidding on work on regular contracts, we would get a better idea of the relative value of percentage and straight contract work. I have never heard of their being successful bidders on any public work, and do know of their reputation of being high bidders on private work. Engineers compare cost of work estimated at the cubic foot contents of a building. Unless buildings are of the same general plan, equally accessible to transportation, to material supplies at equal prices, to equal labor conditions, comparisons are invalid, and yet the percentage men gage the efficiency by these comparisons, and they satisfy their principals by them.

Regarding contracts: Most of them have some blanket clauses which are objectionable, but in our experience we have never been held up by them, and the courts are now looking with disfavor on them. They should be eliminated, and also those other clauses which make the engineer final arbiter. As a matter of fact, I do not think his position is ever maintained unless the questions go to court, and even then testimony is generally able to qualify his decisions.

I have had two kinds of experiences on percentage work. One where the engineers want to run the job; in which cases I have had no interest, and about as much satisfaction as buying and selling shoestrings. In other cases we have been given work, without cost and without price — simply told to do it at our own price and according to our own plans; and on these contracts I have worried more than on fixed-price work, and do not care for the responsibility of inspector and engineer, of explaining some item of cost, of why something went wrong, with the plant or men or natural conditions. For these reasons I do not care for percentage work, and have no great interest in it.

I think I should apologize for this long discussion, as I have written after reading the oral discussions of the meeting, and in that way have had an advantage.

MEMOIRS OF DECEASED MEMBERS.

CHARLES E. PUTNAM.*

CHARLES E. PUTNAM, a member of our Society since 1885, died at his home in Boston on August 20, 1919. He was born in Jackson, Waldo County, Me., August 10, 1859, the son of Daniel and Sarah A. (Tasker) Putnam, and the grandson of Daniel Putnam, an early settler of Searsport, Me., and probably a descendant of John Putnam who came to Danvers, Mass., from England about 1641. His mother was born in Dixmont, Penobscot County, Me., the family having settled there in 1812, coming from Ossipee, N. H., to which town earlier generations of the Tasker family had come from Dover, N. H., where the first of the name in New England, John Tasker, had settled after his arrival from England in 1680.

Mr. Putnam had been in poor health for some time when, on the day of the parade in April, of the returning 26th Division, A. E. F., from France, one of the soldiers being his only son, he watched the march from the reviewing stand on the Common, and caught a violent cold, which so aggravated his old trouble that he was obliged to enter a hospital where he underwent a surgical operation. The disease had progressed so far that it was seen that recovery was impossible, and he returned to his home where after several weeks of intense suffering he died.

Mr. Putnam graduated in 1883 from Maine State College at Orono, and very soon afterwards came to Boston and was employed on the Boston Improved Sewerage work, where he soon gave promise of a successful career as an engineer. In 1887 a large appropriation was made by the City of Boston for park construction, and it became necessary to organize an engineering force for that work. Mr. Putnam was appointed an assistant engineer at Franklin Park, under the direction of the City

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* Memoir prepared by Edward W. Howe and Charles E. Houghton.

Engineer's Department. He also had charge of the engineering work at Jamaica Park, Arnold Arboretum, Franklin Field and some of the smaller parks and playgrounds.

In 1896, upon the separation of the supervision of the park work from the City Engineer's Department, Mr. Putnam for several months was acting superintendent of parks until the appointment of a permanent superintendent, when he was made chief engineer of the Park Department and continued in that office until his death.

Mr. Putnam showed great ability as an engineer, and, working in association with the landscape architects, was able to be of great assistance in the prosecution of the construction of our fine system of public parks. He also developed considerable architectural skill, and designed and supervised the construction of several park buildings. The public playgrounds also called for a good deal of skill and much detail work. All of this was done with such fidelity, honesty and a devoted interest in the work that no question was ever raised as to the character of his service, and the City of Boston owes him a debt of gratitude which, perhaps on account of his extreme modesty, was not always recognized.

Early in his career Mr. Putnam began to be afflicted with deafness, which was a severe handicap and made him of a retiring disposition, so that he was perhaps not very well known among our members; but for this he undoubtedly would have had a greater reputation, and we feel certain that he would have become a leading engineer.

Mr. Putnam married, in 1893, Miss Delia T. Drury, and after her death in 1911 he married her sister, Miss Elisabeth R. Drury, who survives him, as does also one son, Harold, who served in France with the 101st Engineers Regiment and is now in the employ of Messrs. Stone & Webster.

Mr. Putnam, in addition to being a member of our Society, was a member of the American Road Builders Association, the American Association of Park Superintendents, the American Society of Municipal Improvements, the Massachusetts Highway Association, Boston City Club, Dorchester Club and Boston Bowling Green Club.

LESLIE PETER REED.*

LESLIE PETER REED, son of Peter J. Reed and Mary Elizabeth (McDonald) Reed, was born in Hyde Park, Mass., on September 21, 1890. His family moved to Pepperell, Mass., when he was about four years old, and he lived in that town until he graduated from the Pepperell High School in 1908. From 1908 to 1916 he was an assistant to William S. Johnson, C.E., both in office and outside work. During this period he was a student at the Lowell Institute School for Industrial Foremen from 1910 to 1911, and at the Franklin Union in 1913.

While employed by Mr. Johnson he served as rodman, instrumentman, inspector on construction and resident engineer on various projects, among which were the Pepperell Water Works, sewage disposal works for the American Woolen Co. at Maynard; purification works for the manufacturing wastes from Tileston & Hollingsworth's paper mills at Mattapan; and water works at Ashland, Deerfield and Marblehead. Late in 1916 he was assistant superintendent with the Bay State Dredging and Contracting Company, Boston, on Wellesley Extension, Metropolitan High Level Sewer, Needham, Mass.

He went to work for the J. W. Bishop Company in the early part of 1917, as an assistant engineer, and was engaged at the Bridgewater Normal School and at the Naval Air Service Station, Squantum. When work started on Camp Devens he was loaned by the J. W. Bishop Company for work on the water supply and sewerage of that cantonment, and while there was admitted to the first Plattsburg Camp. In reply to a request to the J. W. Bishop Company for data relating to Mr. Reed, Mr. H. S. French of that company wrote in part as follows:

" He was admitted to the First Plattsburg Camp and assigned his commission after the completion of the course. I understood that he was offered a first lieutenancy with an assignment to one of the camps for the purpose of training men, or a second lieutenancy in the Signal Corps with a chance to go abroad immediately, and he took the latter. After a wait of several weeks at Camp Mills, he was transferred to duty in Washington and placed in charge of sewer work at various Signal Corps stations, receiving during this period his promotion to first lieutenancy in the Signal Corps. He was one of the first victims of the influenza epidemic. I have understood from officers who were closely associated with him during his period of service that he was unusually successful in the line of work to which he was assigned."

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* Memoir prepared by F. S. Bailey.

He was elected a junior member of this Society in 1913, and became a member in 1917. On May 13, 1917, he was married to Miss Dora Lunt, of Portland, Me.

Mr. Reed's military record, kindly furnished by the director of air service, is as follows:

" Entered the military service at Reserve Officers' Training Camp, Plattsburg, N. Y., August, 1917. Commissioned second lieutenant, Signal Officers' Reserve Corps, November 27, 1917, and was assigned to the Construction Division, Office of the Chief Signal Officer, which later became the Supply Division of the Division of Military Aëronautics, and is now known as the Supply Section, Office of the Director of Air Service. While on duty in this office he was in charge of design and maintenance of water and sewage systems at aviation fields and supply depots. He was promoted to a first lieutenant, Aviation Section, Signal Officers' Reserve Corps, April 8, 1918, with rank from March 25, 1918, and accepted this commission April 17, 1918. He served in this office from December, 1917, until September, 1918, when he was stricken with pneumonia. He died at the Walter Reed General Hospital, Washington, D. C., September 26, 1918."

As indicating the respect in which Lieutenant Reed was held by his associates in the army, the following letter from Major Burns to Mrs. Reed will be of interest:

SEPTEMBER 27, 1918.

My dear Mrs. Reed, — It was with the deepest regret that I learned of your husband's death, this morning. I have been actively associated with him here in Washington for several months past, and have grown to admire him exceedingly for the earnestness of his efforts, his clear, straight thinking and his forcefulness. These and many other splendid qualities have made him universally respected among those with whom he came in contact. His loss is a great personal blow to us all, and his keen ability and devotion to the cause he was serving so capably will be missed exceedingly.

Let me express my sincere sympathy, in which my associates join.

Faithfully yours,

EDWARD BURNS.

The following words from his obituary notice in the Pepperell *News* also show how he was regarded in his home town:

> "Leslie Reed was brought up by his widowed mother, and forced his way to the front by sheer grit and natural ability. He was a loving and obedient son, a good pupil, a loyal husband, a true brother, and an honored citizen. He was a member of St. Paul Lodge of Masons, Ayer. He is survived by his wife, his mother, and brother, Walter Reed. He was born, married and buried on Sunday."

A letter to Secretary Tinkham from Lieutenant Reed's brother concludes as follows:

> "Leslie always had a warm spot in his heart for the Society, as he spoke about it dozens of times to me.
>
> "His wife, his mother and myself send our appreciation for all past and future interest taken by the Society in our best friend, Leslie."

It is safe to say that all members of this Society who knew Lieutenant Reed at all intimately felt the same regard and affection for him, and sense of loss at his death, as is expressed in the newspaper articles and letters just quoted.

Lacking a college education, he endeavored, with much success, to make up for the deficiency by studying at technical schools and at home after he was employed, and, as he grew in knowledge and experience, he seemed destined to become an even greater credit to the Society than he had, in his regrettably short life, already proved himself to be.

The writer was associated with him for several years, and found him to be a man endowed with sound common-sense; reliable in his work, not only when things were going smoothly but also when conditions were discouraging; good-humored, even-tempered, intelligent and tactful; of exemplary habits, sturdy honesty and thoroughly admirable character.

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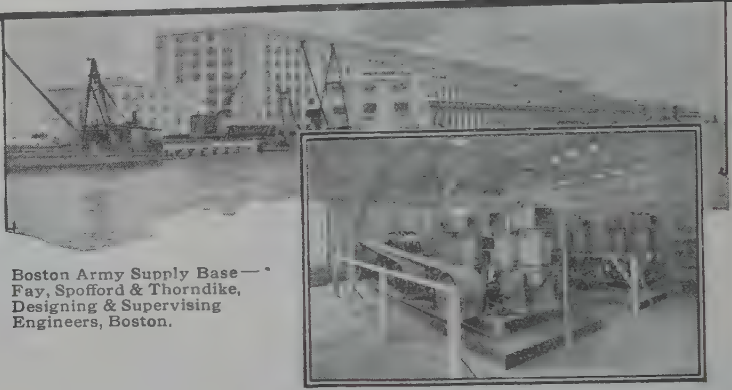

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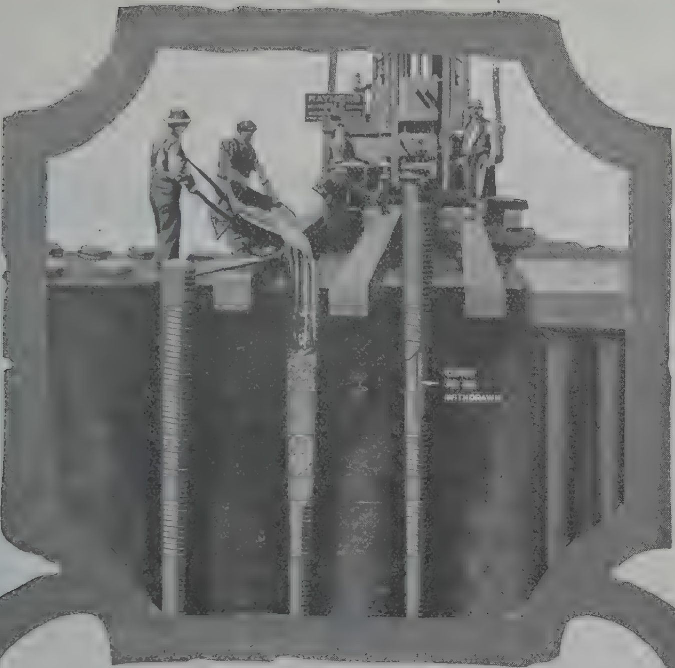

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